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09/723,292	11/28/2000	Satoshi Kajiya	2611-0136P	5509

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EXAMINER	
CHAN, ALEX H	

ART UNIT	PAPER NUMBER
2633	5

DATE MAILED: 08/05/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	09/723,292	KAJIYA ET AL.
	Examiner	**Art Unit**
	Alex H Chan	2633

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 28 November 2000 .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-10 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-10 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 28 November 2000 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 4 .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Specification

1. The disclosure is objected to because of the following informalities:

a) Wavelength converter is referred as item 63 of Fig. 9 (pg. 10, line 4) and the same element is again referred to item 62 (pg. 10, line 5).

b) Optical repeater of item 11 of Fig. 4 (pg. 8, lines 6-7) is not found in the drawing.

Appropriate correction is required.

2. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed. The following title is suggested:

Optical Wavelength Division Multiplexing Transmission Suppressing Four –Wave Mixing and SPM-GVD Effects.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claim 1 is rejected under 35 U.S.C. 103(a) as being unpatentable over U.S Patent No. 5,781,673 to Reed et al (hereinafter referred to as Reed) in view of U.S Patent No. 5,438,445 to Nakano.

5. Regarding claim 1, Reed discloses:

An optical wavelength division multiplexing transmission system comprising:

a first optical fiber transmission path (13 of Fig. 1) for wavelength division multiplex signal to be input therefrom;

A second optical fiber transmission path (14 of Fig. 1) having a zero-dispersion wavelength different from the first optical fiber transmission path (Col. 3, lines 53-55 and Col. 4, lines 52-54, Col. 1, 37-48 and Col. 2, lines 57-65);

Reed does not disclose:

and an optical repeater which receives the wavelength division multiplex signal from said first optical fiber transmission path, wavelength-converts the received signal with respect to respective wavelengths thereof, and outputs the wavelength-converted signal to said second optical fiber transmission path.

However, Nakano, from the same field of endeavor, teaches an add/drop node having wavelength converting functions (Fig. 3). Since Reed's in col. 3, lines 40-55 clearly suggests that add/drop nodes can be added between the two fibers, at the time the invention was made, it would have been obvious to an artisan to incorporate any conventional add/drop node such as the one taught by Nakano to the system of Reed. One of ordinary skill in the art would have been motivated to do this since it allows to simultaneously receiving information from channels from a plurality of optical communication devices (col. 4, lines 27-33 of Nakano) and permits communication between different fibers or optical networks.

6. Claims 1, 2, 5, 7-9 are also rejected under 35 U.S.C. 103(a) as being unpatentable over Reed in view of U.S Patent No. 6,115,173 to Tanaka et all (hereinafter referred to as Tanaka).

In regards to claim 1, Reed discloses a wavelength division multiplexing (hereinafter referred to as WDM) optical fiber communication system with improved dispersion compensation. He discloses a communication system having a first optical fiber for a WDM signal to be input from and a second optical fiber with a zero-dispersion wavelength different from the first optical fiber. His disclosed invention, however, does not disclose an optical repeater as recited in the third element of claim 1.

Tanaka discloses an optical amplifying transmission system and amplifier that can obtain desirable transmission characteristics in a WDM system. In Fig. 1(a), his drawing illustrates an optical transmitter followed by a series of alternate wavelength converters and optical amplifiers. He cites that each wavelength converter, one of the optical amplifiers, and another wavelength converter, as a whole, compose an optical amplifying repeater. One input optical fiber is connected at the front of the optical repeater for sending WDM signals and a second optical fiber is connected at the rear of the optical repeater, constituting a system that wavelength-converts WDM signals from the first fiber and outputs the wavelength-converted signals to the second optical fiber (Col. 3, lines 47-50). By applying this structure into optical transmission system, a plurality of signal lights of different wavelengths can be transmitted by a WDM transmission without any difficult (Col. 4, lines 4-6). Therefore, it would have been obvious to one having ordinary skill in the optical communication art at the time the invention was made to modify the optical communication system of Reed to employ an optical repeater which wavelength-converts an input signal from the first optical fiber and sends such wavelength-converted output signal to the second connecting optical fiber, as taught by Tanaka, for the purpose

of transmitting a plurality of signal lights of different wavelengths by a WDM transmission without any difficulty.

7. In regards to claim 2, Reed discloses a WDM optical fiber communication system with improved dispersion compensation. He discloses a communication system having a first optical fiber for a WDM signal to be input from and a second optical fiber with a zero-dispersion wavelength different from the first optical fiber. However, his transmission system does not disclose an optical repeater that is configured to shift, by a predetermined value, all wavelengths of the WDM signal.

Tanaka discloses an optical amplifying transmission system and amplifier. The object of his invention is to provide an optical amplifying transmission system and amplifier that can obtain satisfactory transmission characteristics in a WDM transmission. In one of the embodiments, a wavelength converter for up-shifting a wavelength of a signal light is inserted at a front part of each of the optical amplifiers as well as an output side wavelength converter for down-shifting a wavelength of a signal light is inserted at a rear step of the optical amplifiers (Col. 3, lines 42-47). The wavelength converter wavelength-shifts the inputting signal lights in a lump into the wavelength band as shown in Fig. 4 (Col. 6, lines 33-38), in order to reduce the influence of four-wave mixing effects and the interference between channels. The wavelength shifting value of the wavelength converters is adjusted so that the signal lights are settled at intervals of the signal lights after wavelength-shift and this amount of wavelength shifted is also predetermined (Col. 10, line 51). He further teaches that the wavelength converter, one of the optical amplifiers and the wavelength converter, as a whole,

compose an optical amplifying repeater (Col. 3, lines 48-50). Therefore, it would have been obvious to one having ordinary skill in the optical communication art at the time the invention was made to modify Reed's optical WDM communication system to include an optical repeater that is configured to shift all wavelengths of the WDM signal by a predetermined value, as taught by Tanaka, for the purpose of suppressing and reducing the effects of four-wave mixing and the interference between channels.

8. In regards to claim 5, Reed discloses a WDM optical fiber communication system with improved dispersion compensation, as stated in the previous rejections. Referring to claim 5, his invention does not disclose an optical repeater of the optical WDM transmission system having been configured for wavelength intervals of the WDM signal input from first optical fiber transmission path to be a constant value $\Delta\lambda$ and for wavelength intervals of the wavelength division multiplex signal output to second optical fiber transmission path to be a constant value $\Delta\lambda'$.

Tanaka discloses two wavelength converters and an optical amplifier as an optical repeater in his optical amplifying transmission system. He teaches that on the occasion of the wavelength conversion, the wavelength converters comprise the bandwidth compressive function for narrowing the channel wavelength intervals and on the other hand, the wavelength converters also comprise the bandwidth expansive function for widening the wavelength intervals between the adjacent channels (Col. 5, lines 51-57). He suggests that it is preferable to have wider intervals on the transmission optical fibers because there is the influence of the interaction between channels such as cross phase modulation and four-wave mixing to deteriorate the transmission characteristics. It is also

preferable to have narrower channel intervals in view of effective use of the optical amplifying bandwidth and the evenness of the gain (Col. 5, lines 42-50). Here it is understood that the wavelength intervals can be configured and adjusted to be constant on the transmission fibers depending on the characteristics of the application being applied to. Therefore, it would have been obvious to one having ordinary skill in the optical communication art at the time the invention was made to modify Reed's optical WDM communication system such that the optical repeater is configured for wavelength intervals of the WDM signal input from first optical fiber transmission path to be a constant value $\Delta\lambda$ and for wavelength intervals of the wavelength division multiplex signal output to second optical fiber transmission path to be a constant value $\Delta\lambda'$, as taught in Tanaka, for the purpose of minimizing cross phase modulation and four-wave mixing while maximizing its bandwidth and gain.

9. In regards to claim 7, Reed discloses a WDM optical fiber communication system with improved dispersion compensation. Nevertheless, he neither teaches nor suggests that the optical repeater of the optical WDM transmission system be comprised of a non-linear element that performs the wavelength conversion.

Tanaka, as cited in the previous rejections, discloses an optical amplifying transmission employing wavelength converters and optical amplifiers, and add/drop apparatuses as optical repeaters for converting wavelengths. He suggests that the wavelength converters can be realized, for example, using non-linear optical effect such as Difference Frequency Generation and four-wave mixing, the principle of electro-acoustic frequency shifter and an electro-absorption modulator or a semiconductor laser

amplifier (Col. 5, lines 25-30). By employing any or in combination of these non-linear elements into optical communication system, the influence of four-wave mixing can be controlled to minimize interference between channels. Therefore, it would have been obvious to one having ordinary skill in the optical communication art at the time the invention was made to modify Reed's optical WDM communication system to include a non-linear element that performs the wavelength conversion, as taught by Tanaka. One would have been motivated to incorporate such non-linear element for the purpose of controlling the effects of four-wave mixing and minimizing the interference between channels.

10. In regards to claim 8, Reed's optical communication system does not disclose an optical WDM system incorporating an optical repeater comprised of one or more semiconductor optical amplifiers.

Tanaka discloses an optical amplifying transmission employing wavelength converters and optical amplifiers, and add/drop apparatuses as optical repeaters for converting wavelengths. He further suggests that the optical repeater of the optical WDM transmission system comprises of one semiconductor laser amplifier or multiple semiconductor laser amplifiers for numerous optical repeaters as a non-linear element that is used to suppress the influence of four-wave mixing. Therefore, it would have been obvious to one having ordinary skill in the optical communication art at the time the invention was made to modify Reed's optical WDM communication system to contain one or more semiconductor laser amplifiers, or semiconductor optical amplifiers. One would have been motivated to integrate a semiconductor laser amplifier into optical

communication transmission system for the purpose of suppressing the influence of four-wave mixing.

11. In regards to claim 9, Reed's optical communication system does not disclose an optical WDM system incorporating an optical repeater comprised of one or more electric field absorption type optical modulators and one or more light sources.

Tanaka discloses an optical amplifying transmission employing wavelength converters and optical amplifiers, and add/drop apparatuses as optical repeaters for converting wavelengths. He suggests that electro-absorption type optical modulators, non-linear elements, can be used as wavelength converters (Col. 3, line29-30). In return, a predetermined value of wavelength is shifted, reducing cross talk, channel interferences and four-wave mixing. It is also known to one skilled in the art that light sources, such as DFB lasers, semiconductor lasers, photodiodes, or LEDs, are used as part of the transmitting stations or components. These light sources send signals and strike against these non-linear components, for example electro-absorption optical modulators that make this method, as a whole, a wavelength-converting process. Therefore, it would have been obvious to one having ordinary skill in the optical communication art at the time the invention was made to modify Reed's optical WDM communication to enclose one or more light sources and electric-field absorption type optical modulators in a WDM transmission system, as taught by Tanaka, for the purpose of forming a wavelength process that is used to suppress cross talk, channel interference, and four-wave mixing.

12. Claims 3 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Reed in view of Tanaka as applied to claim 1 above, and further in view of U.S Patent No. 6,118,561 to Maki.

13. In regards to claim 3, Reed discloses a WDM optical fiber communication system with improved dispersion compensation. He discloses a communication system having a first optical fiber for a WDM signal to be input from and a second optical fiber with a zero-dispersion wavelength different from the first optical fiber. Tanaka discloses an optical amplifying transmission employing wavelength converters and optical amplifiers, and add/drop apparatuses as optical repeaters for converting wavelengths. However, both inventive entities combined do not teach the WDM optical transmission system having an optical repeater that is configured for wavelength intervals of the WDM signal inputted from the first fiber transmission path to be even intervals and for wavelength intervals of the wavelength division multiplex signal outputted to the second fiber transmission path to be uneven intervals.

Maki discloses a WDM optical transmitter and WDM de-multiplexing optical transmission-reception system comprising of a wavelength division demultiplexing optical receiver that includes a wave demultiplexing section in which it consists of a plurality of wave multiplexers connected in parallel and having an equally spaced wavelength optical multiplexing characteristic of demultiplexing an optical signal having wavelengths spaced by substantially equal distances from each other, and an optical reception section for receiving optical signals having wavelengths spaced by unequal distances from each other (Col. 7, lines 40-48). According to his invention, it is

realizable to configure for wavelength intervals of the WDM signal input from the first fiber transmission path to be even intervals and for wavelength intervals of the wavelength division multiplex signal output to the second fiber transmission path to be uneven intervals. Therefore, it would have been obvious to one having ordinary skill in the optical communication art at the time the invention was made to modify Reed's optical WDM communication system to configure the input with even wavelength intervals and output with uneven wavelength intervals. One would have been motivated to make such a modification in view of the suggestion in Maki in order to construct an unequally spaced arrangement of optical wavelengths that can be realized readily and economically.

14. In regards to claim 4, Reed discloses a WDM optical fiber communication system with improved dispersion compensation. He discloses a communication system having a first optical fiber for a WDM signal to be input from and a second optical fiber with a zero-dispersion wavelength different from the first optical fiber. Tanaka discloses an optical amplifying transmission employing wavelength converters and optical amplifiers as optical repeaters for converting wavelengths.. However, neither inventive entity discloses an optical WDM optical transmission system having an optical repeater that is configured for wavelength intervals of the WDM signal input from the first fiber transmission path to be uneven intervals and for wavelength intervals of the wavelength division multiplex signal output to the second fiber transmission path to be even intervals.

Maki discloses a WDM optical transmitter and WDM de-multiplexing optical transmission-reception system. He claims that the WDM optical transmitter, comprising

an optical transmission section for outputting a plurality of optical signals having wavelengths spaced by unequal distances from each other, and a wave multiplexer having an equally spaced wavelength optical multiplexing characteristic of multiplexing a plurality of optical signals having wavelengths spaced by a substantially equal distance from each other, the wave multiplexer being constructed such that, when the plurality of optical signals are inputted thereto from the optical transmission section, the wave multiplexer multiplexes the plurality of optical signals from the optical transmission section into a multiplexed optical signal and outputs the multiplexed optical signal (Col. 2, lines 7-18). This technique provides a WDM multiplexing-demultiplexing optical transmission reception system wherein an unequally spaced arrangement of optical wavelengths can be realized readily and economically to suppress unwanted four-wave mixing. Therefore, it would have been obvious to one having ordinary skill in the optical communication art at the time the invention was made to modify Reed's optical WDM communication system to configure in a way such that the wavelength intervals of the WDM signal input from the first fiber transmission path to be even intervals and for wavelength intervals of the wavelength division multiplex signal output to the second fiber transmission path to be uneven intervals, as taught by Maki, for the purpose of implementing an unequally spaced arrangement of optical wavelengths that can be realized readily and economically to suppress unwanted four-wave mixing.

15. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Reed in view of Tanaka as applied to claim 1 above, and further in view of U.S Patent No. 5,438,445 to Nakano.

In regards to claim 6, Reed discloses a WDM optical fiber communication system with improved dispersion compensation. He discloses a communication system having a first optical fiber for a WDM signal to be input from and a second optical fiber with a zero-dispersion wavelength different from the first optical fiber. Tanaka discloses an optical amplifying transmission employing wavelength converters and optical amplifiers, and add/drop apparatuses as optical repeaters and add/drop apparatuses for converting wavelengths. However, neither inventor discloses an optical repeater that is configured for a number of wavelengths of the WDM signal inputting to the optical fiber to be a natural number "n" and for a number of wavelengths of the WDM signal outputting to the optical fiber to be a natural number "m" where "n" is different from "m."

Nakano discloses an optical WDM communication system that gears toward providing an optical wavelength multiplexing add/drop apparatus which can simultaneously receive information from a plurality of optical communication devices and can simultaneously transmit information to a plurality of optical communication devices. In Fig. 2, through his description of operation of the wavelength converting device in Col.8, lines 13-22, there are removed those optical signals of wavelengths l1 to l6 among the optical signals of wavelengths l1 to l12 from the optical fiber which are useless since they have already been received by the preceding optical wavelength multiplexing add/drop apparatuses prior to arrival thereof to the wavelength-converting device, and the optical signals of wavelengths l7 to l12 as signals to be relayed to the lower stream side of the wavelength-converting device are converted into optical

signals of l1 to l6, respectively (Col. 8, lines 23-33). These 6 optical signals of wavelengths also are inputted to the optical wavelength multiplexing add/drop apparatus, one form of optical repeaters, to generate a set of 8 optical signals of wavelengths at the output. Clearly, it is understood that the number of wavelengths at the input of the wavelength-converting device contains a natural number that differs from the number of wavelengths at the output of the wavelength-converting device. For example, a total number of 12 optical signals of wavelengths enters the wavelength-converting device and only a total number of 6 optical signals of wavelengths exits the wavelength-converting device. Therefore, it would have been obvious to one ordinary skill in the art to modify Reed's optical communication system to incorporate an optical repeater that is configured for a number of wavelengths of the WDM signal inputting to the optical fiber to be a natural number "n" and for a number of wavelengths of the WDM signal outputting to the optical fiber to be a natural number "m" where "n" is different from "m," as taught by Nakano, for the purpose of removing useless optical signals of wavelengths that have already been received by the optical wavelength multiplexing add/drop or other optical repeaters apparatuses.

16. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Reed in view of Tanaka as applied to claim 1 above, and further in view of U.S Patent No. 5,442,476 to Yamazaki et al (hereinafter referred to as Yamazaki).

In regards to claim 10, Reed discloses a WDM optical fiber communication system with improved dispersion compensation. He discloses a communication system having a first optical fiber for a WDM signal to be input from and a second optical fiber with a

zero-dispersion wavelength different from the first optical fiber. Tanaka discloses an optical amplifying transmission employing wavelength converters and optical amplifiers, and add/drop apparatuses as optical repeaters and add/drop apparatuses for converting wavelengths. However, neither inventor discloses an optical repeater comprises one or more light sources and an optical fiber having a non-linear optical effect.

Yamazaki discloses an optical communication method which suppresses waveform distortion caused by an in-optical fiber non-linear optical effect in a long-distance coherent optical communication system (Col. 1, lines 9-11). He shows the variation of the phase before and after transmitting signals to the optical fiber. In Fig. 2(c), he illustrates a curve showing the phase of the signal light before transmission and in Fig. 2(d), he shows the phase of the signal light after transmission. While the variation of the phase before transmission indicates a linear characteristic as seen from Fig. 2(c), the phase variation after transmission presents a non-linear behavior as seen from the curve in Fig. 2(d), meaning that the optical fiber inherits a non-linear optical effect (Col. 2, lines 15-23), causing undesirable results to transmission characteristics. A transmission light source is also indicated in Fig. 1 for transmitting optical signals into the non-linear optical fiber. It is also understood for one skilled in the art from the drawing of Fig. 1 that more than one light sources can be used for transmitting and sending optical signals into the light amplifier repeaters. Therefore, it would have been obvious to one of ordinary skill in the art to modify Reed's optical communication system to contain an optical repeater comprising one or more light sources and an optical fiber having a non-linear effect, as taught by Yamazaki, for the purpose of showing the non-linear optical effect

inherited in the optical fibers which causes undesirable result to the transmission characteristics.

Conclusion

17. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

The following patents are cited to further show the state of the art with respect to optical WDM communication system in general:

U.S. Patent Number: 5,696,614 to Ishikawa et al

U.S. Patent Number: 6,304,348 to Watanabe

U.S. Patent Number: 4,560,246 to Cotter

U.S. Patent Number: 6,188,511 to Marcehac et al

U.S. Patent Number: 5,894,362 to Onaka et al

18. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Alex H Chan whose telephone number is (703)305-0340. The examiner can normally be reached on Monday to Friday (8am to 6pm).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jason Chan can be reached on (703)305-4729. The fax phone numbers for the organization where this application or proceeding is assigned are (703)308-6743 for regular communications and (703)308-6743 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703)305-3900.

Alex Chan
Examiner

Art Unit 2633

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July 24, 2003

JASON CHAN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2600